Listing of Claims

The following listing of claims replaces all prior versions and listings of claims in the application.

Claims 1-57 (Cancelled).

Claim 58 (new): An electron beam apparatus for irradiating a sample with primary electron beams, and detecting secondary electron beams generated from the sample by the irradiation to evaluate the sample surface, comprising:

an electron gun having a cathode for emitting primary electron beams;

a lens positioned near said electron gun;

an objective lens for accelerating secondary electrons emitted from the sample; and

an ExB separator for separating said secondary electrons from a primary electro-optical system and directing them toward a secondary electro-optical system; and

wherein said ExB separator is positioned above said objective lens so that the secondary electrons pass through said objective lens and then are deflected and separated from said primary electro-optical system without entering a lens of said primary electro-optical system.

Claim 59 (new): An electron beam apparatus according to Claim 58, wherein said ExB separator comprises an electrostatic deflector having six or more electrodes, and a troidal or saddle-shaped deflector arranged outside said electrostatic deflector.

Claim 60 (new): An electron beam apparatus according to Claim 58, further comprising:

a speed detector for detecting a moving speed of a stage for carrying the sample thereon; and

a deflection amount correcting device included at least one of the primary and secondary electro-optical systems for correcting the amount of deflection for at least one of the primary electron beams and the secondary electron beams in accordance with the moving speed of the stage from said speed detector.

Claim 61 (new): An electron beam apparatus for irradiating a sample with primary electron beams, and detecting secondary electron beams generated from the sample by the irradiation to evaluate the sample, comprising:

an electron gun having a cathode for emitting primary electron beams;

a lens positioned near said electron gun;

an objective lens for accelerating low energy electrons emitted from the sample;

an ExB separator for deflecting electrons passing through said objective lens toward a secondary electro-optical system;

a plurality of detectors for detecting the intensity of electrons collected through said secondary electro-optical system to convert the intensity to an electric signal,

wherein a spacing between irradiation points of the adjacent primary electron beams is set larger than an extending diameter of back scattered electrons on the sample.

Claim 62 (new): An electron beam apparatus according to Claim 61, wherein the spacing between the adjacent primary electron beams is adjusted by changing a magnification of an electro-optical system from a generation unit of the primary electron beams to the sample.

Claim 63 (new): An electron beam apparatus for irradiating a sample with primary electron beams, and detecting secondary electron beams generated from the sample by the irradiation to evaluate the sample, comprising:

an electron gun having a cathode for emitting primary electron beams;

a lens positioned near said electron gun;

an objective lens for accelerating secondary electrons emitted from the sample; and

an ExB separator for deflecting electrons passing through said objective lens toward a secondary electro-optical system; and

a mechanism for adjusting a beam dimension and a beam current of the primary electron beams to maximize an S/N ratio in a particular pattern in electric signals of the secondary electron beams detected by said detectors.

Claim 64 (new): An electron beam apparatus according to Claim 63, wherein said particular pattern is a regular pattern having a pitch twice a minimum line width of a pattern on the sample under evaluation.

Claim 65 (new): An electron beam apparatus according to Claim 63, further comprising:

an irradiation amount detector for detecting the amount of primary electron beams irradiated to the sample surface; and

an irradiation amount controller for controlling to prevent the amount of irradiated primary electron beam per unit area from exceeding a previously set predetermined value based on the amount of irradiation from said irradiation amount detector.

Claim 66 (new): An electron beam apparatus according to Claim 63, wherein:

said sample is a semiconductor wafer,

said electron beam apparatus further comprises a device for controlling to evaluate a surface of said semiconductor wafer in units of constant stripe widths while continuously moving said stage, and

said irradiation amount controller is adapted to control every area smaller than the length in a stripe direction of a chip multiplied by a stripe width.

Claim 67 (new): An electron beam apparatus according to Claim 63, further comprising a device for switching a ground voltage and a predetermined voltage for application to a connector connected to an external electrode of the semiconductor wafer.

Claim 68 (new): An electron beam apparatus according to Claim 58, further comprising:

a plurality of detectors each for detecting the intercity of electrons collected through the secondary electro-optical system to convert the intensity to an electric signal; and

an image processing unit for processing the electric signals from said detectors into image data.

Claim 69 (new): An electron beam apparatus according to Claim 63, further

an image acquisition device for acquiring a plurality of images of regions under testing displaced while partially overlapping one another on the sample;

a storage device for storing reference images; and

a defect determining device for determining a defect on the sample by comparing a plurality of images of the region under testing acquired by said Image acquisition device with a reference image stored in said storage device.

Claim 70 (new): An electron beam apparatus according to Claim 63, wherein said stage apparatus comprises:

a non-contact supporting mechanism based on a hydrostatic bearing, and a vacuum sealing mechanism based on differential pumping; and

a partition positioned between a location on the sample surface irradiated with the primary electron beams and said hydrostatic bearing support of said stage apparatus. for reducing conductance,

wherein a pressure difference is produced between the electron beam irradiated region and said hydrostatic bearing support.

Claim 71 (new): An electron beam apparatus according to Claim 70, wherein at least surfaces of parts of said stage apparatus facing said hydrostatic bearing are subjected to a surface treatment for reducing an emitted gas.

Claim 72 (new): An electron beam apparatus according to Claim 63, wherein

the sample is carried on a stage apparatus which is accommodated in a housing and supported by hydrostatic bearings with respect to said housing in a non-contact manner;

said housing for accommodating said stage apparatus is evacuated; and

said electron beam apparatus further comprises a differential pumping mechanism provided around a portion of said electron beam apparatus for irradiating the sample surface with the primary electron beams for evacuating the irradiated region on the sample surface.

Claim 73 (new): An electron beam apparatus according to Claim 72, wherein a gas supplied to said hydrostatic bearings of said stage apparatus Is dry nitrogen or highly pure inert gas, said dry nitrogen or said highly pure inert gas being exhausted from said housing for accommodating said stage apparatus, pressurized, and again supplied to said hydrostatic bearing.

Claim 74 (new): An evaluation system for evaluating a sample, comprising:

an electron beam apparatus according to Claim 63;

a working chamber for accommodating a stage apparatus and a primary electron beam irradiating unit of said electron beam apparatus, said working chamber being controllable in a vacuum atmosphere;

a loader for supplying a sample onto said stage apparatus within said working chamber;

a potential applying mechanism disposed within said working chamber for applying the sample with a potential; and

an alignment controller for observing a surface of the sample to control alignment for positioning the sample with respect to an electro-optical system of said electron beam apparatus,

wherein said vacuum working chamber is supported through a vibration isolator for isolating vibrations from a floor.

Claim 75 (new): A semiconductor device which is manufactured and evaluated using an electron beam apparatus according to Claim 63 in the middle of or after termination of a manufacturing process.

Claim 76 (new): A semiconductor device which is manufactured and evaluated using an electron beam apparatus according to Claim 58 in the middle of or after termination of a manufacturing process.

Claim 77 (new): A method of evaluating a sample, using an electron beam apparatus comprising:

irradiating said sample with primary electron beams; detecting secondary electron beams generated from the sample by the irradiation; and

evaluating the sample,

wherein said electron beam apparatus comprises:

an electron gun having a cathode for emitting primary electron beams;

a lens positioned near said electron gun;

an ExB separator for separating said secondary electrons from a primary electro-optical system and directing them to a secondary electro-optical system; and

an objective lens for accelerating said secondary electrons emitted from the sample,

wherein said ExB separator is positioned above said objective lens so that the secondary electrons pass through said objective lens and then are deflected and separated from said primary electro-optical system without entering a lens of said primary electro-optical system.

Claim 78 (new): A method of evaluating a sample according to Claim 77, further comprising:

accelerating secondary electrons emitted from the sample by an objective lens; and

deflecting said secondary electrons to said secondary electro-optical system by an ExB separator which comprises an electrostatic deflector having six or more electrodes, and a troidal or saddle-shaped deflector arranged outside said electrostatic deflector.

Claim 79 (new): A method of evaluating a sample according to Claim 77, further comprising:

detecting a moving speed of a stage for carrying the sample thereon; and

calibrating the amount of deflection for at least one of the primary electron beams and the secondary electron beams in accordance with the moving speed of the stage detected at the speed detection.

Claim 80 (new): A method of evaluating a sample according to Claim 77, further comprising:

adjusting a beam dimension or a beam current of the primary electron beams to maximize a contrast or an S/N ratio in a particular pattern in electric signals of the secondary electron beams detected by said detectors.

Claim 81 (new): A method of evaluating a sample according to Claim 77. further comprising:

detecting the amount of primary electron beams irradiated to the sample; and

controlling to prevent the amount of irradiated primary electron beam per unit area from exceeding a previously set predetermined value based on the amount of irradiation obtained by detecting the irradiated amount.

Claim 82 (new): A method of manufacturing a semiconductor device, comprising:

preparing a wafer,

processing said wafer; and

evaluating said wafer during the wafer processing, using a method according to Claim 77.

Claim 83 (new): A method of evaluating a sample according to Claim 77, further comprising:

comparing an image of a standard pattern for the sample with an actual image of the sample generated by said electron beam apparatus, wherein an image of a particular location on the sample which is expected to suffer defects when a pattern under testing is formed on the sample with a corresponding standard pattern image, or with a pattern image for the sample which is expected to suffer less defects.

Claim 84 (new): A method of evaluating a sample according to Claim 77, further comprising:

acquiring a plurality of images of regions under testing displaced while partially overlapping one another on the sample;

storing a reference image; and

determining a defect on the sample by comparing each of the acquired images of the region under testing, with the stored reference image.